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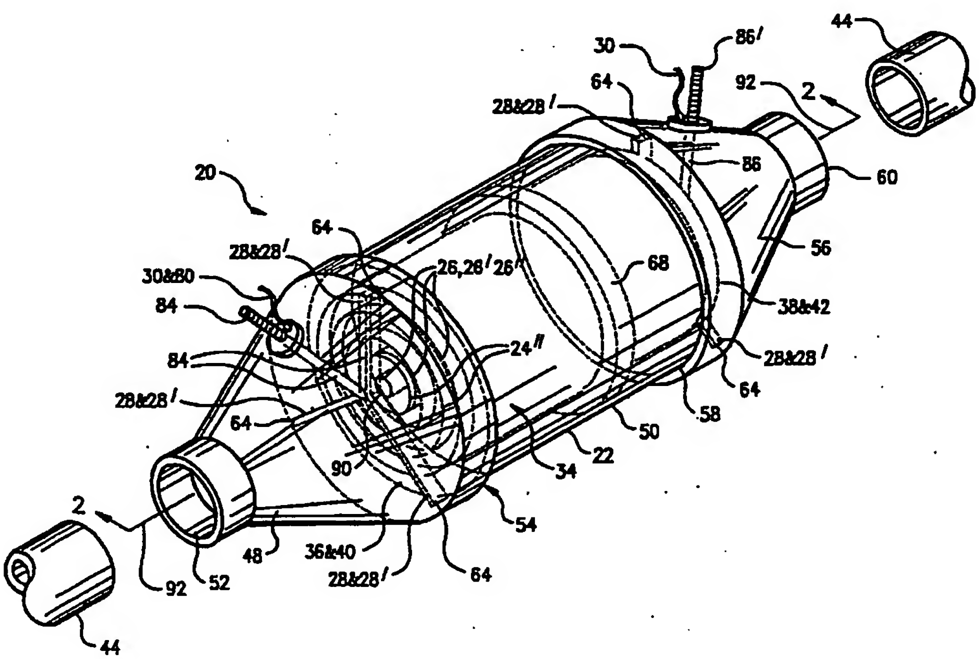

(57) Abstract

Apparatus (20) having a housing (22), a first electrode (24), a second electrode (26), securing means (28), current means (30) and methods for treating liquids by electrolytically generating dissolved oxygen within water and electrolytically purifying and/or removing contaminants from the water.

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Title: ELECTROCATALYTIC DISSOLVED OXYGEN GENERATOR FOR WATER PROCESSING

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TECHNICAL FIELD

This invention relates to apparatus and methods for electrolytically treating liquids. More particularly, this invention relates to apparatus and methods for generating dissolved oxygen within water and for electrolytically purifying and/or removing contaminants from the water.

BACKGROUND ART

A widely recognized problem within open and closed hydraulic systems is the depletion or degradation of dissolved oxygen within water. This problem is particularly significant within environments that are highly dependant upon dissolved oxygen. For xample, large and small bodies

of water that support aquatic and marine life require the generation and maintenance of large amounts of dissolved oxygen. Dissolved oxygen is a necessary requirement for the survival of aquatic organisms living in lakes, rivers, and other bodies of water. Fish will die if the dissolved oxygen level drops below a given point. Persons familiar with aquatic and marine life often measure the quality and health of a body of water by the amount of dissolved oxygen present.

Similarly, certain processes such as those used within paper processing plants, water purification plants, and sewage treatment plants require the generation of large amounts of dissolved oxygen.

Various attempts have been made to aerate such bodies of water and, thereby, increase the amount of dissolved oxygen contained therein. For example, air or gaseous oxygen have been forced under water and allowed to escape and bubble to the surface in an attempt to increase the level of dissolved oxygen within water. The main problem with gaseous oxygen, however, is that it is difficult to dissolve into water above a given saturation point.

Other attempts to encourage oxygen entry into water include spraying the water into the air, mechanically splashing the surface of the water, and subjecting the water to intense elevated pressures within a pressurized container. Mechanical methods of spraying the water into the air or mechanically splashing the water are very inefficient methods to produce dissolved oxygen. Furthermore, such mechanical methods ar unable to reach higher levels of dissolved oxygen

with any degree of stability.

In an unrelated area of technology, electrolysis has been used to break apart the various molecules of H_2O or water to produce gaseous hydrogen and gaseous oxygen. It is important to note, however, the significant difference between gaseous oxygen and dissolved oxygen.

The inventor has dedicated much of his life to the study of open and closed hydraulic systems. On April 17, 1990, U.S. Letters Patent No. 4,917,782, issued in the name of the inventor for an electrolytic liquid purification process and apparatus. The apparatus and processes disclosed within U.S. Letters Patent No. 4,917,782 are significantly different from those of the present invention. Other disclosures that were considered in the prosecution of that patent include: Hughes, Jr. et al. (U.S. Letters Patent No. 2,864,750; issued December 16, 1958); Mehl (U.S. Letters Patent No. 3,523,891; issued August 11, 1970); Doevenspeck (U.S. Letters Patent No. 3,679,556; issued July 25, 1972); Preis et al. (U.S. Letters Patent No. 3,728,245; issued April 17, 1973); Cassanovas et al. (U.S. Letters Patent No. 3,835,018; issued September 10, 1974); Phipps (U.S. Letters Patent No. 3,865,710; issued February 11, 1975); Okert (U.S. Letters Patent No. 3,925,176; issued December 9, 1975); Frame (U.S. Letters Patent No. 4,419,206; issued December 6, 1983); Neymeyer (U.S. Letters Patent No. 4,425,216; issued January 10, 1984); Branchick et al. (U.S. Letters Patent No. 4,436,601; issued March 13, 1984); Paniagua (U.S. L tters Patent No. 4,572,775; issued February 25, 1986); and Umehara (U.S. Letters Patent No.

4,623,436; issued November 18, 1986).

The inventor believes that the listed disclosures taken alone or in combination neither anticipate nor render obvious the present invention. The cited disclosures do not constitute an admission that such are relevant or material to the present claims. Rather, the aforementioned disclosures relate only to the general field of the invention and are cited as constituting the closest art of which the inventor is aware.

DISCLOSURE OF INVENTION

The present invention comprises simple, easily used, inexpensive apparatus and methods for generating high levels of dissolved oxygen within water and for electrolytically purifying and/or removing contaminants from the water in an environmentally safe fashion. The invention is compact, unobtrusive, functional, efficient, reliable, reusable, durable, rugged, easily constructed, inexpensive and economical to manufacture, and is easily installed and removed if needed. Minimal installation and access room is needed. A minimum amount of manipulation is required for installation. Once installed, the invention is extremely simple to use and maintain. The apparatus of the invention does not require very much space. Consequently, replacement parts also require a minimal amount of storage space. The present invention significantly increases the speed, simplifies the procedure, and dramatically enhances the efficiency of elevating the oxygenation level within a body of wat r.

In addition t the f reg ing benefits and other advantages that will be described further below, the present invention also overcomes all of the previously mentioned disadvantages of apparatus and processes heretofore used for the stated purpose. For example, a significant benefit of the present invention is that it can be used within a closed, hydraulic conduit or pipeline. The present invention eliminates the need for bulky, expensive, complex, and maintenance intensive surface spray and mechanical aerators. No longer must a business enterprise or municipality purchase large tracks of land for aeration, settlement, and treatment ponds. The aeration or dissolved oxygen generation process no longer must be exposed to surface air which creates aromatic, zoning, and ecology related problems.

Installation of the invention does not mandate an extensive capital investment that would otherwise be required. The cost to maintain the invention is insignificant in comparison to the expense of building and maintaining the type of commercial aeration projects now in use. The savings to commercial enterprises by using this invention also includes not having to hire, pay, and contribute fringe benefits to numerous support personnel. The dangers of falling into open ponds and catching a finger, hand, limb, or clothing in operating machinery are also eliminated.

To accomplish the aforementioned objectives, the present invention uses el ctrolysis proc ss s to break apart water molecules and cause oxygen, created th reby, t go directly

into a dissolved state. Du to the catalytic properties and action of the invention, the oxygen molecules do not pass through a gaseous state but rather are forced to assume an immediate dissolved state throughout the conversion process. The oxygen, in effect, bypasses the gaseous stage that is otherwise required by other processes.

The resulting dissolved oxygen levels are relatively stable due to the cell design and do not require pressurization during the process. In addition, the dissolved oxygen generating abilities of the invention are relatively unaffected by the presence of minerals, chemicals or organic materials that are present within the water. In fact, the invention scrubs or removes such contaminants from the water. The cell is noncontaminating and does not introduce any additional metal, mineral, or chemical components into the water.

The invention represents a dramatic and significant improvement over the electrolysis-type processes disclosed in the inventor's earlier granted patent (U.S. Letters Patent No. 4,917,782). There is no need to precondition the water, as is usually required in other electrolysis-type processes. There is no need that particular minerals be present in the water for operation of the processes. In addition, water passing through the apparatus is not further contaminated by the process, as commonly occurs during other electrolysis-type process s where untreated metal el ctrodes dissolve.

The inventor knows of no other apparatus, wherein apparatus using an el ctrolysis process has been solely

designed for the pr ducti n of dissolv d oxygen within water. Some electrolysis processes do produce minimal amounts of dissolved oxygen as a byproduct. However, such processes are unable to produce the higher levels of dissolved oxygen that can be achieved by using the present invention.

Heretofore, using unprocessed water at 30 degrees centigrade such mechanical devices and/or processes could only obtain a maximum level of dissolved oxygen concentration of 7.6 parts per million (ppm). Processed water at 30 degrees centigrade could contain a maximum level of dissolved oxygen concentration of 10 parts per million (ppm) before reaching an insurmountable saturation point.

In comparison, unprocessed water at 30 degrees centigrade that is passed through the present invention can readily obtain a dissolved oxygen concentration level of 20 parts per million.

Another method that has been used to generate elevated concentrations of dissolved gases is exposing the water or fluid to excessive gas pressurization. For example, carbonated water or soda generally uses pressurization to obtain higher levels of gas saturation.

The elevated dissolved oxygen levels obtained through the present invention, however, are not obtained through the use of carbonation or elevated pressures. The water is not carbonated. The aforementioned results are accomplished with n significant additional pressurization. The lack of pressurization is important t note. The processes us d within the present invention in eff ct change the gas

balances of the water. In other words, the present invention rearranges the various gas percentages of oxygen, nitrogen, and contaminants within the water.

Henry's law generally states: The concentration of a gaseous solute in a solution, C_g, is directly proportional to the partial pressure, p_g, of the gas above the solution. The resulting equation is $C_g = k_g p_g$, wherein k_g represents Henry's law proportionality constant. For example, at 25 degrees Celsius, oxygen gas collected over water at a total pressure of 1.00 atmosphere (atm) is soluble to the extent of 0.0393 grams per liter.

Accordingly, if the altitude and temperature of an open body of water are known, one can determine the level of dissolved oxygen within the water by using Henry's law.

Henry's law, however, assumes that the percentage of gas contained within the water will be the same as that of the surrounding atmospheric air, or in other words seventy-eight percent (78%) nitrogen and twenty-one and nine-tenths percent (21.9%) oxygen.

The inventor has discovered that by electrocatalytically forcing oxygen within the water into a dissolved state, the apparatus of the present invention can create an unstable or quasi-stable condition. In effect, the dissolved gases contained within the water can exceed the heretofore believed absolute saturation limit of one hundred percent (100%).

During the electrocatalytic process, some of the dissolved oxygen within th water vap rates, or bleeds or boils off, along with a corresponding amount of nitrogen. As

a result, an almost stable condition is obtained. At this point the one hundred percent (100%) dissolved gas limit is not yet exceeded. However, since nitrogen has been purged or expelled from the system, the water can directly and immediately absorb a comparable amount of dissolved oxygen without the oxygen having to enter a gaseous state. Thus, the concentration of dissolved oxygen can be increased without a similar increase in dissolved nitrogen. The oxygen level increases, and the nitrogen level decreases.

Consequently, the present invention allows one to reach triple saturation very easily and not violate Henry's law. The amount of gas in the solution remains at 100% to 101%, but processed repetitively, most if not all of such gas will be oxygen.

The apparatus is preferably placed within systems that recirculate water. Every time the water passes through the apparatus, more nitrogen is displaced and the level of dissolved oxygen increases. This process can continue until approximately twenty-two (22) parts per million of dissolved oxygen are achieved and maintained, regardless of the temperature of the water, as long as the water temperature is below fifty (50) degrees Celsius. For example, the present invention can achieve and maintain a concentration of twenty-two (22) parts per million of dissolved oxygen all day long when the water was at thirty (30) degrees Celsius.

A c nventional use of Henry's law, how ver, would generally limit the concentration amount dissolved oxygen to around six (6) or (7) parts per million. In other words,

according to Henry's law, the given b dy f water should have a dissolved oxygen concentration level of around 6 parts per million, but by using this invention the concentration level may be maintained at about 22 parts per million.

When trying to aerate water by pumping or blowing air underwater and then allowing the gas to bubble to the surface, the injected air comprises approximately seventy-eight percent (78%) of nitrogen and twenty-two percent (22%) of oxygen. The relative percentage of absorption of such gases is comparable to the respective amounts of gas injected below the water. Consequently, with the increase in dissolved oxygen, there is a significant (in excess of threefold) increase in the amount of dissolved nitrogen. Many fish and other aquatic life are sensitive to high nitrogen levels and can become embolized if the nitrogen levels are excessive.

In comparison, the level of dissolved oxygen can be effectively doubled, tripled, and even quadrupled in a single pass of water through the system without any absorption of dissolved nitrogen. The results of this process far exceed that what can be achieved by using air blowing or other older techniques.

A different method to obtain dissolved oxygen is to first liquefy air to separate off the oxygen. The oxygen is then stored in pressurized tanks for later injection back int the water reservoir. After being injected back into the water reservoir, the oxygen is allowed to again bubble back to the surface. Several problems with this method include

the added expense and difficulty to separat off the oxygen, and the cost and trouble to handle, store, and transport flammable pressurized oxygen tanks.

Besides the significant reduction in cost, required equipment, and manual labor as compared to the previously mentioned pressurized method, the present invention generates dissolved oxygen. Unlike gaseous oxygen, dissolved oxygen is not explosive. Consequently, the present invention is much safer to use and operate. In addition, once the apparatus is installed, the only needed component to operate the apparatus is a flow of water and a direct electrical current. It is usually much more convenient to obtain and maintain a supply of electricity than to keep replenishing a supply of pressurized oxygen tanks.

In effect, the inventor has discovered that by increasing the amount of dissolved oxygen in water, the oxygen molecules can actually displace and thereby remove or reduce the amount of dissolved minerals, oils, and organic matter contained in the water. Not only is healthier water created, but the cleaning process does not use additional chemical additives to do so.

The inventor has actually created an electronically controlled scrubbing device that scrubs contaminated water at a molecular level.

More particularly, the apparatus of the present invention can be used to treat water having physical, chemical, and/or bi logical contaminants. Although not a cur -all for every water problem, dissolved oxygen generation

with electronic purification will help or cur c ntamination problems in most cases. The following explanation describes how the invention affects each type of contamination.

The electrical flow and field generated by the invention causes a coagulation or lumping together of solids, colloids, and thin oils that comprise physical contaminants within water.

In addition, the electrolysis within the electrolytic or electrocatalytic cell of the invention adds large amounts of dissolved oxygen to the water that in turn cause the oxidation and destruction of many other contaminants. As a result of the coagulation and oxidation just mentioned, once the water is allowed to settle, the contaminants easily fall or settle out of the solution.

Such coagulation, oxidation, and removal of settled contaminants eliminate algae, hydrogen sulfide, and other elements that create most obnoxious odors. For example, the presence of hydrogen sulfide generally creates a smell of raw sewage.

It is important to note that by using the electrocatalytic purification apparatus and processes described herein, such purification can be accomplished without using or adding other chemicals or agents to treat the water.

Chemical contaminants can also be reduced by subjecting the water to the high levels of dissolved oxygen. The dissolved xygen oxidizes and breaks down many ch micals and hydrocarbons in low concentrati ns. Minerals and dissolved

metals in the wat r also coagulate into filterable s lids as do many soaps and phosphates.

Biological contamination can be safely and effectively treated using the present invention. It is important to note that dissolved oxygen is an effective, natural bactericide that is not toxic to animals, fish, or plants.

Anaerobic bacteria live without oxygen. An example of a virulent type of anaerobic bacteria is that commonly found in stagnant water. The simple introduction of oxygen into the water generally kills anaerobic bacteria.

Aerobic bacteria, which live with oxygen, can also be killed by introducing additional dissolved oxygen into the water. This is accomplished by raising the level of dissolved oxygen until the aerobic bacteria die. What happens is that excess oxygen breaks down the outer wall of the bacteria cell causing the death of the organism. Consequently, to the inventor's knowledge no bacteria, not even the microscopic organisms, are immune to high levels of dissolved oxygen.

Because dissolved oxygen remains in the water, long pipe lengths and storage tanks can be cleansed and purified of contaminants by what is referred to as a residual kill attributed to dissolved oxygen.

Dissolved oxygen can also be used very effectively to kill fecal coliform bacteria this is found in waters having sewage contamination. For exampl , many cities use oxygen to purify the water output being expelled from sewage plants. This is d ne because the introduction f oxygen is an

effective way to treat water without incurring harmful environmental side effects.

The noncontaminating nature and qualities of this invention make the apparatus particularly valuable for use with fish farms, lakes, drinking water, and other environmentally sensitive water reserves. The invention can similarly be used within aquatic, waste water treatment, sewage treatment, water purification, paper processing, and many other industries that require high levels of dissolved oxygen within the water. Large open bodies of water can now be economically maintained having a stable, balanced, supersaturated state of dissolved oxygen.

The primary purpose of the invention, is not necessarily the coagulation of contaminants, although this is an extremely beneficial by-process. Instead, the primary purpose of the invention is to increase the level of dissolved oxygen within the water.

The present invention is a flow-through system. In other words, the invention allows the water to pass right through the apparatus without having to force the water in or out of the apparatus. The system is preferably not serpentine in shape or operation. If the system was serpentine within the cell itself, turbulence would be introduced and the system would not work as well. Consequently, the invention permits high water flow rates with only a minimum amount of drag or flow resistance. The rate of flow can and should be substantially constant.

The invention can be installed into and will not interfere with most water pumping and storage systems.

The construction and materials used within the invention make the apparatus and processes used nearly, if not completely, immune to normal water pressure and temperature changes.

To achieve the aforementioned general and specific objectives, the present invention generally comprises a housing, a first electrode or electrical conductor, a second electrode or electrical conductor, securing means, and current means. Each of these elements and additional elements will be discussed in substantial detail below within the Best Mode For Carrying Out The Invention portion of the patent and are included herein by reference.

These and other objectives and advantages of the present invention will become more readily apparent upon reading the following disclosure and referring to the attached drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is an isometric view of a preferred embodiment of the invention illustrating a specially designed electrocatalytic cell, depicted in phantom lines, within an exterior housing.

FIG. 2 is an enlarged, cross-sectional, side-elevational view of the invention shown in Figure 1, further illustrating placement and interconnection of the various components of the apparatus.

FIG. 3 is a partially exploded, isometric view of the invention illustrating the internal components of the

electrocatalytic cell.

FIG. 4 is a transverse, cross-sectional view of the invention as seen within a plane defined by line 4-4 in Figure 2.

FIG. 5 is a schematic diagram showing various additional components that can be used with the apparatus to aerate, oxygenate, and treat an open aquatic or marine pond, such as a fish pond.

FIG. 6 is a schematic diagram of an alternative form of putting the invention into practice to aerate, oxygenate, and treat waste water from a paper mill.

One should understand that the drawings are not necessarily to scale and the elements are sometimes illustrated by graphic symbols, phantom lines, diagrammatic representations, and fragmentary views. In certain instances, the inventor may have omitted details which are not necessary for an understanding of the present invention or which render other details difficult to perceive.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring to the drawings, wherein like numerals indicate like parts, the present invention generally comprises an apparatus 20 having a housing 22, a first electrode 24, a second electrode 26, securing means 28, and current means 30.

The housing 22 defines an enclosure 32 within which an electrolytic or electr catalytic cell 34 is c ntained. The h using 22 can have any desired cross-s cti nal configuration and be of any desired length. In the preferred embodiment of

the invention, the housing 22 has an elongat d, tubular, generally cylindrical shape. Rectangular, triangular, square, or other cross-sectional shapes may alternatively be used.

The inventor believes that the minimum exterior size of the housing 22 can be as small as a one (1) inch outer diameter. The inventor believes that the maximum exterior size of the housing 22 can be as large as a six (6) feet outer diameter.

The housing 22 has a first end 36 and an opposed second end 38. An inlet opening 40 or port is located at the first end 36. An outlet opening 42 or port is located at the opposed second end 38.

The housing 22 can be directly connected or secured to a conduit or pipe 44 in any manner that permits the generally collinear passage of water 46 into the inlet opening 40, through the enclosure 32, and out of the housing 22 through the outlet opening 42.

The inventor prefers that the pipe 44 have a diameter of about two (2) to three (3) inches. Of course, other sizes of pipe 44 can alternatively be used.

The housing 22 may be provided with an inlet coupling 48 that is connected between the pipe 44 and a main portion 50 of the housing 22 that encloses the cell 34. The inlet coupling 48 is designed to provided a gradually increasing taper from an inlet end 52 to an opposed outlet nd 54. The tapered design is intended t provid for a smooth flow of the water 46 through th apparatus 20. The inlet nd 52 has

a narrower cross-sectional area or circumference as compared to the opposed outlet end 54. Similarly, the outlet end 54 has a larger cross-sectional area or circumference as compared to the opposed inlet end 52. The narrower inlet end 52 is sized and dimensioned to be secured to an opening within the pipe 44.

The housing 22 could also be provided with an outlet coupling 56. The outlet coupling 56 is generally similar to the design of the inlet coupling 48. More particularly, the outlet coupling 56 is connected between the pipe 44 and the main portion 50 of the housing 22 that encloses the cell 34. The outlet coupling 56 has an inlet end 58 and an opposed outlet end 60. The inlet end 58 of the outlet coupling 56 has a wider cross-sectional area or circumference as compared to the opposed outlet end 60. Similarly, the outlet end 60 of the outlet coupling 56 has a narrower cross-sectional area or circumference as compared to the opposed inlet end 58. The narrower outlet end 60 is sized and dimensioned to be secured to an opening within the pipe 44.

The housing 22, inlet coupling 48, and outlet coupling 56 should be manufactured from a material that does not conduct electrical current. For example, it is preferred that the housing 22, inlet coupling 48, and outlet coupling 56 be manufactured from a PVC, Teflon, nylon, or any other nonconductive material. Of course, other materials could alternatively be used.

The joint or junctures b tween the inlet coupling 48, main portion 50 of the housing 22, and the outlet coupling 56

may be sealed and secured by any appropriate means, such as by a threaded connection or use of an adhesive.

The cell 34 contains a plurality of bipolar, preferably tubular-shaped electrodes. The first electrode 24 and second electrode 26 are positioned or located within the enclosure 32 defined by the main portion 50 of the housing 22 between the inlet opening 40 and outlet opening 42.

The first electrode 24 may comprise any desired shape or configuration that accomplishes the desired objectives. The first electrode 24, however, should be capable of carrying an electrical charge and current.

The second electrode 26 may also comprise any desired shape or configuration that accomplishes the desired objectives. The second electrode 26 should also be capable of carrying an electrical charge and current.

The first electrode 24 is juxtaposed near to the second electrode 26. However, there is a spaced relationship between the first electrode 24 and the second electrode 26. It is important to remember that the water 46 must be capable of passing between the first electrode 24 and the second electrode 26 in a generally unimpeded manner, and an electrical charge and current must be capable of being passed through the water 46 from the first electrode 24 to the second electrode 26.

To achieve a fixed or adjustable spaced relationship between the first el ctrode 24 and the sec nd electr de 26, securing m ans 28 that acc mplish this task ar pr vided. Such securing means 28 secur the first electrode 24 and the

second el ctrode 26 within the main portion 50 of the housing 22 in such a manner that the spaced relationship between the first electrode 24 and second electrode 26 can be easily maintained. The securing means 28 may take any desired form or design that accomplishes the required task. One particular form for the securing means 28 will be discussed in more detail further below.

Although other configurations can be used with this invention, the interior of the cell 34 preferably consists of two (2) or more coated tubular shaped catalytic electrodes 24 and 26 or curved plates. For example, in the preferred embodiment of the invention, the first electrode 24 comprises a plurality of elongated, coaxially-positioned, tubular plates 24'. For increase efficiency, the plates 24' of the first electrode 24 should have a generally collinear orientation with respect to passage of the water 46 through the enclosure 32.

In a similar manner, the second electrode 26 also comprises a plurality of elongated, coaxially-positioned, tubular plates 26'. The plates 26' of the second electrode 26 should also have a generally collinear orientation with respect to passage of the water 46 through the enclosure 32.

Since most hydraulic conduits or pipelines have a generally hollow, cylindrical shape, it is preferred that the plates 24' and 26' of the first electrode 24 and second electrode 26 also comprise elongated, g nerally hollow, cylindrical shapes. When placed within the h using 22, the plates 24' and 26' should have successively larger diameters

so that they fit in a telescopic manner within one another.

Of course, other configurations of the plates 24' and 26' can alternatively be used, if desired. However, to minimize the amount of turbulence of the water 46 passing through the enclosure 32, the inventor prefers to use plates 24' and 26' that have successively larger but similar cross-sectional design as that of the pipe 44. The preferred configuration of the plates 24' and 26' is that of a hollow, cylindrical tube, pipe, or bent plate.

The plates 26' of the second electrode 26 are interposed between respective, proximate plates 24' of the first electrode 24. Although the present invention functions in a very different manner, the design is similar to that of a multi-plated capacitor using successively larger or smaller spaced tubes placed within one another.

The spaced interposition of the plates 24' and 26' is important so that a closed electrical circuit can be created only when water 46 is passed between the plates 24' and 26'. Furthermore, with one exception that will be discussed further below, it is desirable that the amount of surface area facing the respective interposed plates 24' and 26' be maximized to better facilitate passage of current therefrom and affect a greater amount of water 46 passing therebetween.

Such interposition may be accomplished by using securing means 28 that spaces the plates 26' of the second electrode 26 in an interposed relationship between the plates 24' of the first electrode 24. For example, the inv ntor prefers to use generally "Y"-shaped plate or el ctrode spac rs, end

braces, or guides 28' to quickly and easily h ld and space the plates 24' and 26' relative to one another. The spacers or guides 28' are adhered or otherwise secured to the plates 24' and 26'. A friction fit between the spacers or guides 28' and the plates 24' and 26' may be sufficient. Alternatively, the spacers or guides 28' may be provided with notches 62, channels, or indentations therein that are designed to receive and retain the variously sized plates 24' and/or 26'. The outermost edges 64 of the nonelectrically conductive spacers or guides 28' may be braced or otherwise secured to the interior sidewalls 66 of the housing 22.

The securing means 28 may further comprise means for preventing the passage of the water 46 through the enclosure 32 except between the first electrode 24 and the second electrode 26. For example, a spacing or spacer ring 68 may be placed between the plates 24' and 26' and the interior sidewalls 66 of the main portion 50 of the housing 22.

To maximize the amount of retained dissolved oxygen within the water 46, the housing 22, the first electrode 24, the second electrode 26, the securing means 28, and the current means 30 are all configured and dimensioned to reduce turbulence within the water 46 passing through the enclosure 32, thereby allowing the water 46 to maintain a maximum laminar flow.

To minimize turbulence, the inventor prefers to use a housing 22 that has the same general cross-sectional c nfigurati n as the pipe 44. In additi n, after placement of the cell 34 within the housing 22, the remaining cross-

secti nal area available for passag of the water 46 through the enclosure 32 should comprise approximately the same area, or generally comparable cross-sectional area, as that of the interior area of the pipe 44. As a result, there should be no appreciable increase or decrease in the pressure within the water 46 as the water 46 passes through the enclosure 32.

The inventor desires to eliminate adverse venturi affects within the apparatus 20 and system. If a venturi affect occurs, there will be a lowering of water pressure. If there is a pressure drop, gases will come out of the solution which is undesirable.

Consequently, the cross-sectional area of the apparatus 20 is enlarged, as compared to the input pipe 44. Such enlargement accounts for the added cross-sectional dimensions of the internal components within the apparatus 20. The rate of flow of the water 46 through the system should not dramatically increase or decrease.

To further reduce turbulence within the enclosure 32, the inventor prefers to use plates 24' within the first electrode 24 and plates 26' within the second electrode 26 that have a respective leading edge 24" and 26" that is tapered to a relatively sharp edge. Similarly, the trailing edge 24"' of the plate 24' should be tapered to a relatively sharp edge. The trailing edge 26"' of the plate 26' should also be tapered to a relatively sharp edge. Tapering of the leading and trailing edges further reduce turbulence within th water 46.

The invention also cont mplates the use of current means 30 for supplying a direct electrical current to the first electrode 24, through the water 46, and into the second electrode 26 to form a closed electrical circuit or loop. In effect, the current means 30, the first electrode 24, the water 46, and the second electrode 26 define the electrolytic or electrocatalytic cell 34.

In the preferred embodiment of the invention, the current means 30 comprises an electrical power supply 80 or source that is positioned externally from the housing 22 or cell 34. For example, a power supply 80 similar that described in U.S. Letters Patent No. 4,917,782 may be used with the present invention.

The first and second electrodes 24 and 26 are connected to the power supply 80 and are thereby electrically active in the water 46 solution. In is important to note that each electrode 24 and 26 are set in electrically insulated material that insures proper spacing and minimum current leakage between the electrodes 24 and 26.

A very low voltage is used. For example, in a typical application the power supply 80 delivers about one (1) volt to sixty (60) volts of direct current to the plate 24' and 26' defining the cell 34. The actual amount of voltage will depend upon the conductivity, temperature, and elevation of the water 46.

The cell 34 operates on about 0.5 amperes to 600 amperes depending upon the size and length of th first and second electrodes 24 and 26 (respectively comprising plates 24' and

26'), and dep nding upon the charact ristics of th water 46 such as its conductivity.

Electrical charges and currents within these ranges do not adversely effect fish.

In addition, the system uses an isolated direct current (DC) voltage system within the cell 34. Since the fish are not allowed to go through the cell 34, the fish are not adversely effected. The passage of the fish can be blocked by an input screen (not shown). Even if the input screen was removed, the fish would not be able to pass through the filters and related equipment used with the cell 34. There is no voltage leakage outside of the cell 34 back to the pond at all. The transformer is isolated from the alternating current (AC) line and only director current (DC) is exposed to the water 46. Consequently, the only electrical flow occurs within the cell 34 itself.

Normally, when water 46 is heated the amount of dissolved oxygen contained therein will necessarily decrease. Because of this problem, one would be motivated not to heat the water 46. Since subjecting the water 46 to an electrical current will necessarily heat the water 46, commonly accepted principles teach away from the present invention.

However, when water 46 is heated its conductivity actually increases. The increased conductivity of the water 46 counteracts any lowering of the total amount of dissolved gas contained within th water 46 due to the t mperature increase. Consequently, the processes of the present invention can b effectuated without adv rse impact from the

water 46 becoming partially heated.

Since water is not as electrically conductive when cold, the present invention functions even better when the water is warmer or heated. At higher temperatures, the apparatus 20 works extremely well.

The first electrode 24 and the second electrode 26 are bipolar. Consequently, an electrical timer 82, similar to that described in U.S. Letters Patent No. 4,917,782, can be used to periodically reverse the polarity within the cell 34. By reversing the polarity within the cell 34, debris adhering to the plates 24' and 26' can be urged to fall off.

The time periods for electrical current reversals vary depending upon the type and amount or level of water contamination and the debris buildup. The inventor prefers a minimum reversal time period of about ten (10) minutes. A maximum reversal time period should be about eight (8) hours. Due to this electrically self-cleaning feature, no mechanical cleaning of the cell 34 is generally required.

The oxygen generation process described herein uses non-consumable catalytic type electrodes 24 and 26 and/or plates 24' and 26'. The spacing of the first and second electrodes 24 and 26 and shape of the cell 34 are designed to maximize or optimize dissolved oxygen production. The applied voltage and current levels are also designed to maximize production of dissolved oxygen.

The spacing between respective plates 24' and 26' varies from about 0.1 inch to 1.0 inch d pending on the type of water contamination that is b ing treat d. The desired flow

rates, pipe size, and type of contamination being treated will primarily dictate the number of electrode plates 24' and 26' that must be used.

Power is supplied to the electrode plates 24' and 26' positioned within the enclosure 32 by means of one or more cables, wires, and/or straps 84 and 86 that are welded or otherwise electrically connected or secured to plates 24' and 26', respectively. In the preferred embodiment, an electrically conductive strap 84 is provided for the set of plates 24' that comprise first electrode 24. Similarly, an electrically conductive strap 86 is provided for the set of plates 26' that comprise second electrode 26.

The strap 84 is connected in a parallel fashion to each plate 24' within the first set of electrodes 24. The strap 86 is connected in a parallel fashion to each plate 26' within the second set of electrodes 26.

The opposed terminal ends 84' and 86' of the straps 84 and 86 are past through the sidewall 66 of the housing 22, whereupon the terminal ends 84' and 86' are connected to the external power supply 80 by any convenient manner. Thus configured, an electrical current can be past through the cell 34 once water 46 fills the gap between the respective plates 24' and 26'.

To reduce the amount of maintenance required by the invention, the electrically conductive straps 84 and 86 are welded to each electrode plate 24' or 26' within that particular s t of electrodes 24 or 26, respectively.

If the straps 84 and 86 have any significant width thereto, a slot 88, channel, or notch may be cut into each electrode plate 24' or 26' to accommodate the placement of the straps 84 or 86 therein. As a result, the straps 84 and 86 may be mounted or placed edgewise within the flow path of the water 46 and thereby minimize its affect on turbulence within the water 46.

Within the preferred embodiment of the invention, a centermost portion of the cell 34 comprises a solid, thin, cylindrical water block 90. Water block 90 may or may not be tapered to a point. The water block 90 is designed to further prevent water 46 from passing through the enclosure 32 without first passing between two oppositely charged electrode plates 24' and 26' and thereby being electrocatalytically treated.

The reader is reminded of the above-mentioned spacing or spacer ring 68, that is placed between the plates 24' and/or 26' and the interior sidewalls 66 of the main portion 50 of the housing 22. That spacing or spacer ring 68 also prevents the passage of the water 46 through the enclosure 32 except between the first set of plates 24' that define the first electrode 24 and the second set of plates 26' that define the second electrode 26. Thus positioned, water 46 cannot bypass the cell 34 unless a different bypass pipe (not shown) is used.

The centermost cylindrical water block 90, the outermost spacing or spacer ring 68, the plat or lectrode spacers or guides 28', the inlet coupling 48, the outlet coupling 56,

and the interior sidewalls 66 of the housing 22 are all preferably manufactured from an electrically nonconductive material such as, but not limited to, PVC, Teflon, or nylon.

To facilitate proper welding of the electrical straps 84 and 86 to the appropriate sets of plates 24' and/or 26', both the straps 84 and 86 and both sets of plates 24' and 26' or electrodes 24 and 26 are preferably manufactured from titanium. Of course, other metals may also be used, but the inventor prefers to use titanium.

In addition, either or both of the sets of plates 24' and/or 26', such as the first electrode 24 and/or the second electrode 26, are coated with iridium oxide, ruthenium oxide, rhodium oxide, palladium oxide, osmium oxide, platinum oxide, or any other coating material that enhances the capability of the cell 34 to perform its function. The inventor, however, has found that the particularly selected metals and coatings used for the cell 34 as stated herein have unique catalytic properties.

To further enhance the efficiency of the cell 34, the leading edge 24" of each plate 24' within the first electrode 24 is set forward of or set backward of each proximate leading edge 26" of each plate 26' within the second electrode 26. The aforementioned spacing along the longitudinal axis 92 of the cell 34, as determined by the passage of water 46 through the enclosure 32, should be about ne to one and ne-half inches (1" to 1-1/2") between the l ading edges 24" of th plates 24' of the first electrode 24 and the leading edges 26" of the plates 26' of the second

electrode 26. In other w rds, the leading edges 24" of th plates 24' forming the first electrode 24 should not be aligned with each proximately positioned leading edge 26" of the plates 26' forming the second electrode 26. This misalignment is intended to make sure that the plates 26' are not within the electrical flow that supplies power to plates 24'. Similarly, the plates 24' should not be within the electrical flow that supplies power to plates 26'.

Furthermore, the leading edges 24" and 26" and the trailing edges 24"' and 26"' of plates 24' and 26" should not be actively involved within the electrolysis process or excessive wear may occur.

The present invention may be practiced without the use of a mechanical filter. In effect the invention can be practiced without the use of consumable chemicals, filters, or other related equipment. No chemicals are used in this process other than for ph adjustment.

Alternatively, if desired, one or more filters 94 may be operatively connected to the housing 22 or be placed upstream and/or downstream from the apparatus 20 within the pipe 44. For example, the filter 94 may remove contaminants from the water 46 before the water 46 passes through the enclosure 32. Figure 5 illustrates the filter 94 installed upstream of the apparatus 20. The filter 94 may take any desired form. However, the filter 94 should not significantly retard the flow f water 46 through the apparatus 20.

The water 46 may b gravity fed thr ugh the pipe 44 and thr ugh the apparatus 20.

To prevent excessive build-up within th holding tank 100, the inventor uses a flood sensor (not shown) that governs the input of waste water 46' through the input pipe 44.

Alternatively, one or more pumps 96 may be used to increase the pressure of the water 46 and thereby urge the water 46 to pass through the enclosure 32. The pump or pumps 96 can be operatively connected to the apparatus 20 or to the pipe 44, or actually be integrally formed within the housing 22 of the apparatus 20.

The invention is intended for use with water circulation apparatus to clean and purify the water 46 and remove the minerals therefrom. Prior to passing through the apparatus 20 and/or after having passed through the apparatus 20, the water 46 may be deposited into a holding pond 98, holding tank 100, or the like. Figure 5 schematically illustrates the use of the holding pond 98, such as an open aquarium, fish pond, waste water treatment pond, aquarium, hot tub, or swimming pool.

Figure 6 schematically illustrates the use of the apparatus 20 with one or more enclosed holding tanks 100. In essence, the holding tank 100 is operatively connected to an input pipe 102. The holding tank 100 is capable of holding or detaining the water 46 after the water 46 has past through the enclosure 32, thereby permitting contaminants within the water 46 to settle to a bottom 104 of the holding tank.

To achieve this end, contaminated water 46 is initially pumped int the holding tank 100 through input pipe 102 where

the water 46 is stored. Each holding tank 100 is provided with an inlet port 106 and an outlet port 108. The inlet port 106 is positioned near a lower portion 110 of the holding tank 100 to receive unprocessed water 46' therethrough. The outlet port 108 is positioned near an upper portion 112 of the holding tank 100 to permit removal of processed water 46" therethrough.

Some of the contaminants may be mechanically removed from the unprocessed water 46' by means of one or more filters 94 that are placed within the input pipe 102.

Once passed into the holding tank 100 through the inlet port 106, some of the contaminants may settle out of the unprocessed water 46' before the water 46 is past into the cell 34.

The unprocessed water 46' is drawn from near the bottom 104 or middle portion 114 of the holding tank 100 and is pumped into the cell 34 where the water 46 is electrocatalytically scrubbed. After exiting the cell 34, the processed water 46" is pumped back into the holding tank 100 whereupon the coagulated contaminants can settle to the bottom 104 of the holding tank 100.

Due to the high electrical flow between the plates 24' and 26', high dissolved oxygen levels ionize and coagulate the solids within the water 46 thereby causing such solids to precipitate. The oxidized solid waste can then be removed from the bottom 104 of the holding tank 100. Hydr gen-sulfide, phenols, and trac oils can all be broken down by using this method. In particular, when BOD and COD have

their oxygen demand met and th n exceeded by a large amount, the breakdown of the waste is very rapid.

In comparison, the generation of dissolved oxygen using other technologies is very slow, from hours into days and weeks, due to an inability to effectively produce high dissolved oxygen levels.

With the present invention, however, the cell 34 is specially designed to maximize the production of dissolved oxygen in water 46 flowing through it. The shape of the parts of the apparatus 20 are designed to reduce turbulence and to maintain a high level of dissolved oxygen within the water 46. Furthermore, the selection of voltage and current levels are also set to maximize dissolved oxygen generation.

With each successive pass through the cell 34, the water 46 is further purified. In addition, with each pass nitrogen gas is being expelled from the processed water 46" and is being immediately replaced with dissolved oxygen that is created during the electrocatalytic process.

The holding tank 100 preferably has a vent 116 located near its uppermost portion 118. Gaseous nitrogen, oxygen and/or other undesired gases that are expelled from the cell 34 will float to the upper surface 120 of the holding tank 100, whereupon such gases can be vented, released, or expelled to another holding tank 101' for further processing or be vented to the outside atmosphere. The venting of such gases eliminates the possibility that such gases will be reabsorbed back into th processed water 46".

As a consequenc of using the discl sed apparatus 20 and processes, processed, purified water 46" will naturally migrate to the upper portion 112 of the holding tank 100. In effect, a stratification of the water 46 occurs. As the water 46 becomes more gasified or has less contaminants therein, such processed water 46" rises upward. Unprocessed water 46' containing contaminants that are clumped together fall to the bottom. Consequently, natural stratification occurs. Eventually the processed water 46" floats to the top of the holding tank 100 and unprocessed or less processed water 46' falls to a lower level for reprocessing.

The apparatus 20, and particularly the holding tank 100, may also be provided with means for removing settled contaminants from the bottom 104 of the holding tank 100. Any appropriate means to accomplish this task may be used.

The processed water 46" that remains near the upper surface 120 of the holding tank 100 can be drawn off by gravity or be pumped off into another holding tank 100', whereupon the process is again repeated.

The present invention can be used without a holding tank 100 (as shown in Figure 5), with a single holding tank 100, or with a plurality of holding tanks 100, 100' and 100". At each successive level or passage to the next holding tank 100, 100' and 100", the processed water 46" will become progressively purified of contaminants, will have significant amounts of dissolved nitrogen displaced th refrom, and will eventually hav extremely high volumes f diss lved oxygen contained therein.

As seen in Figure 6, a cell 34 is not installed within the third or last illustrated holding tank 100". By the time the water 46 reaches the third tank 100", the levels of dissolved oxygen contained within the water 46 are very high. Consequently, the advantageous effects imparted by high levels of dissolved oxygen will continue even after the production of dissolved oxygen ceases. The inventor refers to this as a residual kill process where contaminants are continuing to be purged from the water reservoir within holding tank 100".

In comparison, if only ozone is introduced into the water 46, fifteen seconds down the pipe 44 the ozone has dissipated and is no longer effective. If the present invention is used, a residual kill continues for an extended period of time because, according to Henry's law, the balance of dissolved gases within the water 46 must be maintained.

Chlorine may be placed within the water 46 and residual kill will occur for a substantial period of time. However, chlorine stays in the solution.

Dissolved oxygen functions in a similar manner as chlorine but dissolved oxygen is eventually released into the atmosphere and the water solution is allowed to equalize. Thus, the present invention is much more ecologically friendly to the environment than using chlorine.

The present invention contemplates not only the apparatus 20 disclosed and claimed herein, in all of its forms and alternativ embodiments, but also contemplates the described methods and processes for increasing the amount of

dissolved xygen within water 46 and br aking down the molecular structure of water borne organisms.

Basically the process passes low direct current (DC) voltage, using a catalytic-type cell 34, through water 46. The catalytic action of the cell 34 forces most of the oxygen that is broken apart from water molecules to go directly into a dissolved oxygen state.

The dissolved oxygen levels that can be created by these processes can increase a dissolved oxygen saturation point from around three parts per million (3.0 ppm) to about twenty parts per million (20.0 ppm), depending on the starting conditions of the water 46. Under some circumstances, certain dissolved minerals react with the oxygen slowing down the oxygen generation process.

Such processes or methods may include the following steps:

First, passing water 46 through a conduit or pipe 44 into a housing 22 that defines an enclosure 32.

Second, passing the water 46 between a first electrode 24 and a second electrode 26 contained within the enclosure 32. The first electrode 24 and second electrode 26 each are capable of carrying an electrical charge and current. The first electrode 24 is juxtaposed near the second electrode 26 in a spaced relationship to the second electrode 26.

Third, supplying a direct electrical charge and current to the first electrode 24 so that the direct electrical current passes through the first electrode 24, through the water 46, and into the second electrode 26 to form a closed

electrical circuit or loop. The means for supplying the direct electrical current, the first electrode 24, the water 46, and the second electrode 26, in fact, define an electrolytic and/or electrocatalytic cell 34. The direct electrical current should be sufficient, when passed through the water 46, to break apart water molecules. The direct electrical current should also be sufficient to break down the molecular structure of water borne organisms and/or chemicals by means of electrolysis and by oxidization created from the breaking apart of the water molecules.

Example

A small pond having a temperature of 30 degrees Celsius and a medium fish loading would typically have a dissolved oxygen saturation point of 7.6 parts-per-million (ppm). If the fish loading or containment is higher, the dissolved oxygen saturation point would be slightly less than 7.6 ppm.

When using other technologies, such as with air blowers as described above, the dissolved oxygen saturation point of 7.6 ppm can be maintained. Under perfect conditions, using such apparatus might obtain a maximum saturation point of around 9.0 ppm. A higher amount of dissolved oxygen would result in healthier fish with better food conversion ratios.

Use of air blowers, however, requires a substantial amount of electrical power. For example, a typical rate of power usage would be approximately 5.0 kilowatts per hour.

Using the apparatus of the present inv ntion, the very same pond can be asily maintained with a dissolved oxygen saturation point of 14.0 to 16.0 ppm. The power requirements

to obtain such a dissolved oxygen saturati n point would only be 0.9 kilowatts of electrical power per hour.

To accomplish this phenomenal improvement, the apparatus only needs to use eight (8) electrode plates and have a diameter of three (3) inches. The power requirement would be twenty-four (24) volts of direct current at thirty-seven (37) amperes. The flow rate of the treated water would be seventy (70) gallons per minute. The entire treatment system would consist of only the power supply, the cell, a filter, and a pump for water movement.

It should be noted that the inventor has experimented with apparatus 20 having different cross-sectional configurations and has discovered that the design illustrated in the accompanying drawings can generate approximately eighty percent (80%) more dissolved oxygen per watt of power than a system that uses flat, planar plates, as opposed to the cylindrical plates 24" and 26" discussed above.

The means and construction disclosed herein are by way of example and comprise primarily the preferred forms of putting the invention into effect. Although the drawings depict preferred and alternative embodiments of the invention, other embodiments have been described within the preceding text. One skilled in the art will appreciate that the disclosed device may have a wide variety of shapes and configurations. Additionally, persons skilled in the art to which the invention pertains might consider the foregoing teachings in making vari us modificati ns, ther embodiments, and alternative forms of the invention.

It is, ther for , to b und rstood that the invention is not limited to the particular embodiments or specific features shown herein. To the contrary, the inventor claims the invention in all of its forms, including all alternatives, modifications, equivalents, and alternative embodiments that fall within the legitimate and valid scope of the appended claims, appropriately interpreted under the Doctrine of Equivalents.

INDUSTRIAL APPLICABILITY

The present invention may be utilized wherever simple, reliable, easily used apparatus and methods are needed to increase the level of dissolved oxygen within a body of water. For example various aquatic, waste water treatment, sewage treatment, water purification, paper processing, and many other plants and industries require high levels of dissolved oxygen within the water. The apparatus of this invention is compact, functional, unobtrusive, efficient, reusable, durable, rugged, is easily constructed, and is inexpensive and economical to manufacture.

The present invention has a special benefit of allowing its use with a wide variety of differently sized water conduits or pipelines. The apparatus may be easily manufactured with the appropriate length, width, and/or diameter to fit the needs of a particularly required application.

The present invention may be secured to the conduit or pipeline in areas of extremely limited access. This f ature makes th apparatus particularly unobtrusive and useful in

areas wh re aesthetics are important, such as with residential fish tanks.

Preexisting conduits or pipelines may be utilized. Other than to install the apparatus, there is no need to modify, alter, or deface the preexisting machinery. Alternatively, the invention may be incorporated into or formed integrally within new hydraulic systems.

CLAIMS

What is claimed is:

Claim 1. Apparatus for increasing amount of dissolved oxygen within water passing through a conduit or pipe, said apparatus comprising:

(a) a housing defining an enclosure therein, said housing having a first end and an opposed second end, said housing having an inlet opening at said first end, said housing having an outlet opening at said second end, said housing capable of being secured to the conduit or pipe in a manner permitting the collinear passage of the water into said inlet opening, through said enclosure, and out of said outlet opening;

(b) a first electrode capable of carrying an electrical current positioned within said enclosure;

(c) a second electrode capable of carrying an electrical current positioned within said enclosure, said first electrode being juxtaposed near said second electrode in a spaced relationship to said second electrode, the water capable of passing between said first electrode and said second electrode;

(d) means for securing said first electrode and said second electrode in spaced relationship one to another within said enclosure; and

(e) means for supplying a direct electrical current to said first lectrode, through the water, and into said second electrode to form a closed electrical circuit or loop,

said current means, said first electrode, the water, and said second electrode defining an electrolytic or electrocatalytic cell.

Claim 2. The apparatus of Claim 1, wherein said first electrode comprises a plurality of elongated, coaxially-positioned, tubular plates, said plates of said first electrode having a generally collinear orientation with respect to passage of the water through said enclosure.

Claim 3. The apparatus of Claim 2, wherein said second electrode comprises a plurality of elongated, coaxially-positioned, tubular plates, said plates of said second electrode having a generally collinear orientation with respect to passage of the water through said enclosure, said plates of said second electrode being interposed between respective plates of said first electrode.

Claim 4. The apparatus of Claim 3, wherein said plates of said first electrode comprise hollow cylindrical plates.

Claim 5. The apparatus of Claim 4, wherein said plates of said second electrode comprise hollow cylindrical plates.

Claim 6. The apparatus of Claim 3, wherein said securing means further comprises means for spacing said plates of said second electrode in an interposed relationship between said plates of said first electrode.

Claim 7. The apparatus of Claim 6, wherein said plates of said first electrode and said plates of said second electrode each have a leading edge and a trailing edge, each said leading edge being tapered to reduce turbulence within the water.

Claim 8. The apparatus of Claim 7, wherein each said trailing edge is tapered to further reduce turbulence within the water.

Claim 9. The apparatus of Claim 7, wherein each said leading edge of said first electrode is not aligned with each proximate said leading edge of said second electrode, each said leading edge of said first electrode being set forward of or set backward of each proximate said leading edge of said second electrode.

Claim 10. The apparatus of Claim 1, wherein said securing means prevents passage of the water through said enclosure except between said first electrode and said second electrode.

Claim 11. The apparatus of Claim 1, wherein said housing further comprises an inlet coupling having a narrower inlet end and a larger outlet end, said narrower inlet end of said inlet coupling capable f being s cured to the conduit or pipe.

Claim 12. The apparatus f Claim 1, wh rein said housing further comprises an outlet coupling having a larger inlet end and a narrower outlet end, said narrower outlet end of said outlet coupling capable of being secured to the conduit or pipe.

Claim 13. The apparatus of Claim 1, wherein said housing, said first electrode, said second electrode, said securing means, and said current means are dimensioned to reduce turbulence within the water and provide a passage for the water through said enclosure that has a generally comparable cross-sectional area to that of the conduit or pipe.

Claim 14. The apparatus of Claim 1, further comprising at least one holding tank operatively connected to the conduit or pipe, said holding tank capable of holding or detaining the water after the water has passed through said enclosure to permit contaminants within the water to settle to a bottom of said holding tank.

Claim 15. The apparatus of Claim 14, wherein said holding tank further comprises means for removing contaminants that settle to said bottom of said holding tank.

Claim 16. The apparatus of Claim 14, wherein said holding tank further comprises a vent through which undesired gases held within said holding tank may be r l ased or

expelled.

Claim 17. The apparatus of Claim 16, wherein said holding tank is provided with an inlet port and an outlet port, said inlet port being positioned near a lower portion of said holding tank to receive unprocessed water therethrough, said outlet port being positioned near an upper portion of said holding tank to permit removal of processed water therethrough.

Claim 18. The apparatus of Claim 1, further comprising at least one pump operatively connected to the conduit or pipe, said pump urging the water to pass through said enclosure.

Claim 19. The apparatus of Claim 1, further comprising at least one filter operatively connected to said housing or to the conduit or pipe, said filter removing contaminants from the water before the water passes through said enclosure.

Claim 20. The apparatus of Claim 1, wherein said first electrode is coated with iridium oxide, ruthenium oxide, rhodium oxide, palladium oxide, osmium oxide, or platinum oxide.

Claim 21. The apparatus f Claim 20, wherein said second electrode is coated with iridium oxide, ruthenium oxide, rhodium oxide, palladium oxide, osmium oxide, or platinum oxide.

Claim 22. The apparatus of Claim 1, wherein said first electrode is manufactured from titanium.

Claim 23. The apparatus of Claim 22, wherein said second electrode is manufactured from titanium.

Claim 24. A method for increasing the amount of dissolved oxygen within water and breaking down the molecular structure of water borne organisms, said method comprising the steps of:

(a) passing the water through a conduit or pipe into a housing defining an enclosure;

(b) passing the water between a first electrode and a second electrode contained within the enclosure, the first electrode and the second electrode each capable of carrying an electrical current, the first electrode being juxtaposed near the second electrode in a spaced relationship to the second electrode;

(c) supplying a direct electrical current to the first electrode so that the direct electrical current passes through the first electrode, through the water, and into the sec nd el ctrod to form a closed electrical circuit or loop, th current means, the first electrode, the

water, and the s cond electrode defining an electrolytic or electrocatalytic cell, the direct electrical current being sufficient when passed through the water to break apart water molecules, the direct electrical current further being sufficient to break down chemicals by means of electrolysis and by oxidization created from the breaking apart of the water molecules.

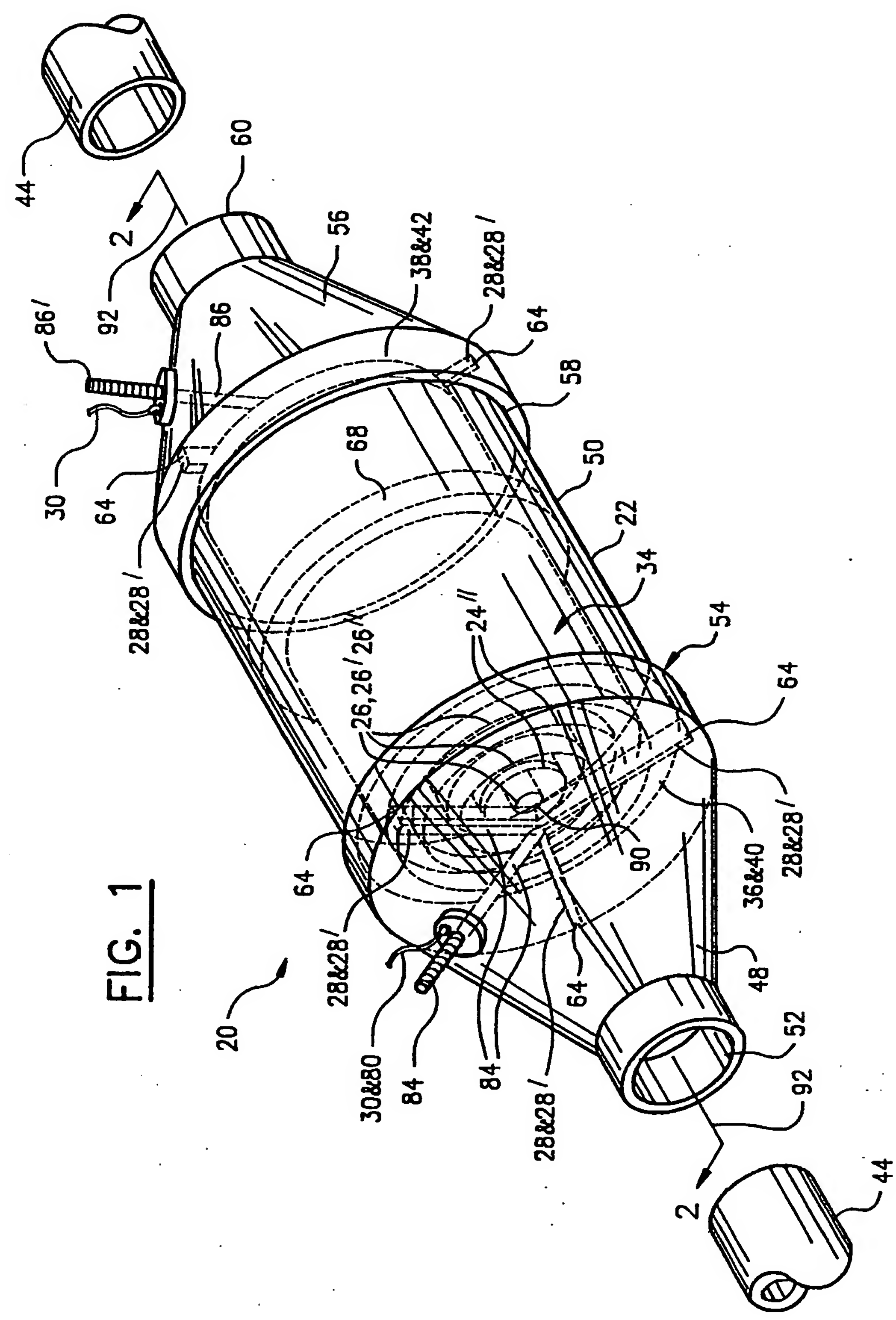
Claim 25. A method for increasing the amount of dissolved oxygen within water and breaking down the molecular structure of water borne organisms, said method comprising the steps of:

(a) passing the water through a conduit or pipe into a housing defining an enclosure;

(b) passing the water between a first electrode and a second electrode contained within the enclosure, the first electrode and the second electrode each capable of carrying an electrical current, the first electrode being juxtaposed near the second electrode in a spaced relationship to the second electrode;

(c) supplying a direct electrical current to the first electrode so that the direct electrical current passes through the first electrode, through the water, and into the second electrode to form a closed electrical circuit or loop, the current means, the first electrode, the water, and th sec nd electrode defining an electrolytic or electrocatalytic cell, th dir ct electrical current being sufficient when passed through the wat r to break

apart water molecules, the direct electrical current further being sufficient to break down the molecular structure of water borne organisms by means of electrolysis and by oxidization created from the breaking apart of the water molecules.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60
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92
86'
56
38&42
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64
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58
30
64
68
50
22
28&28'
34
24''
26,26'26'
54
64
28&28'
36&40
90
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28&28'
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30&80
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84
28&28'
64
48
52
92
2
44

FIG. 1

2/5

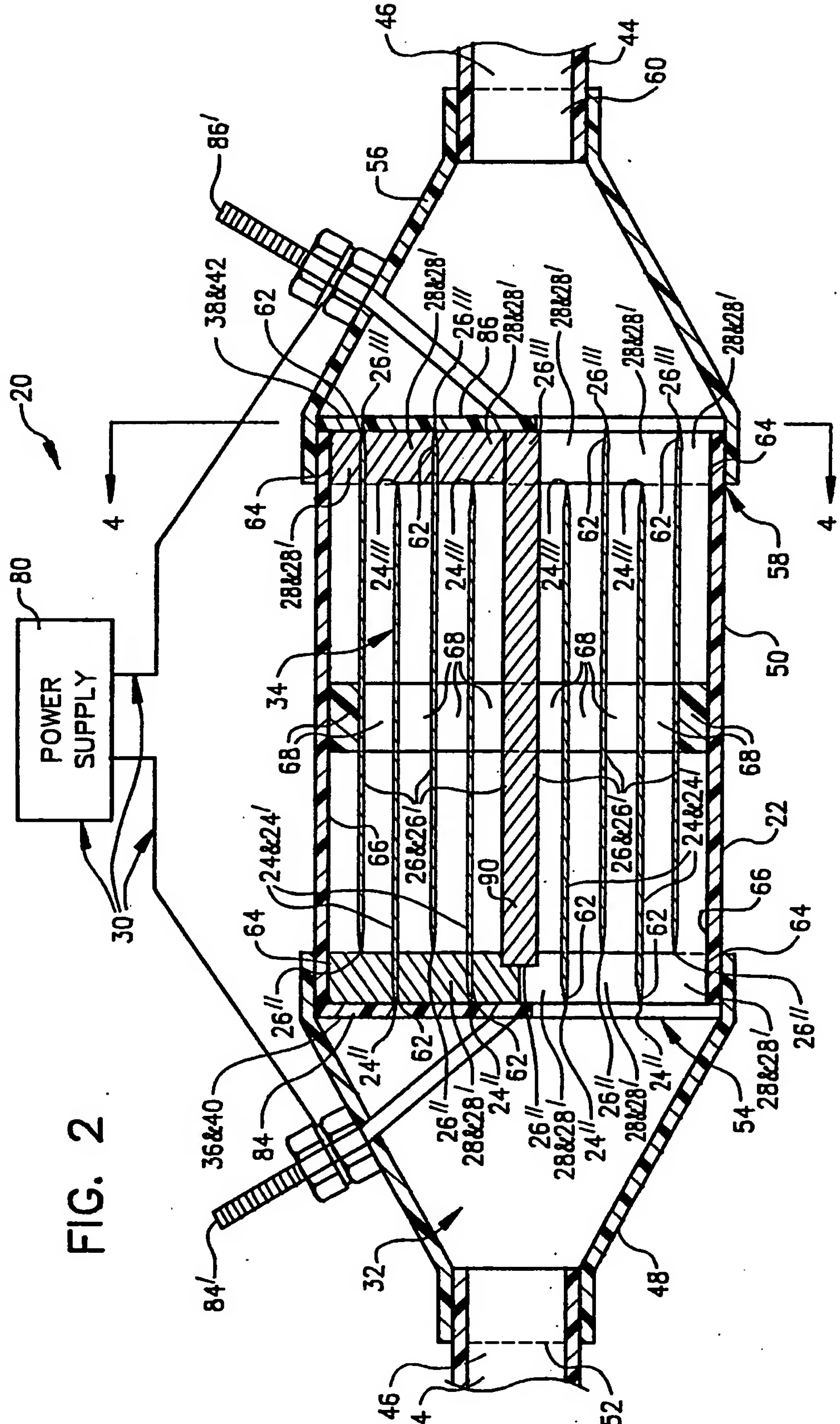


FIG. 2

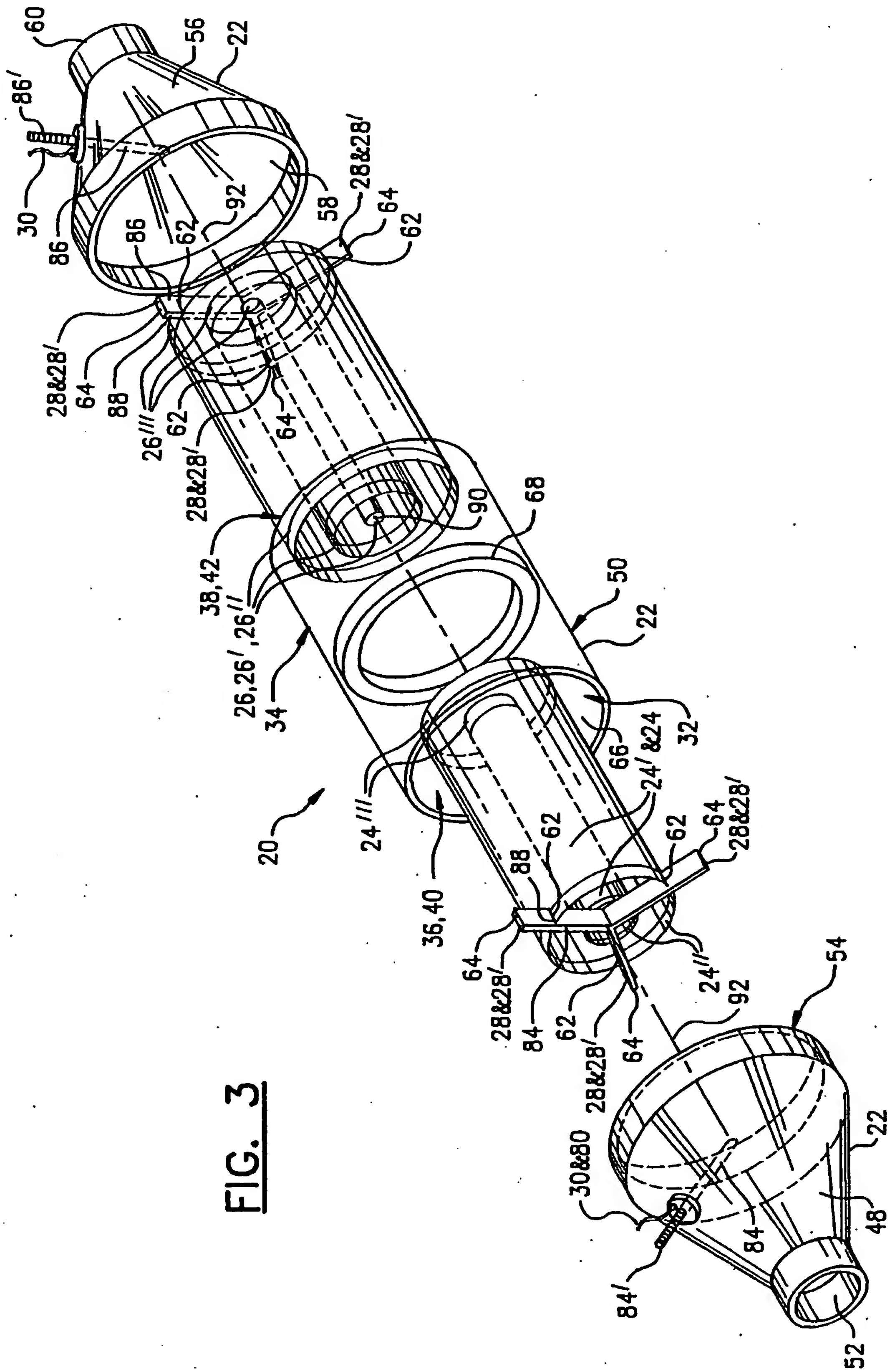


FIG. 3

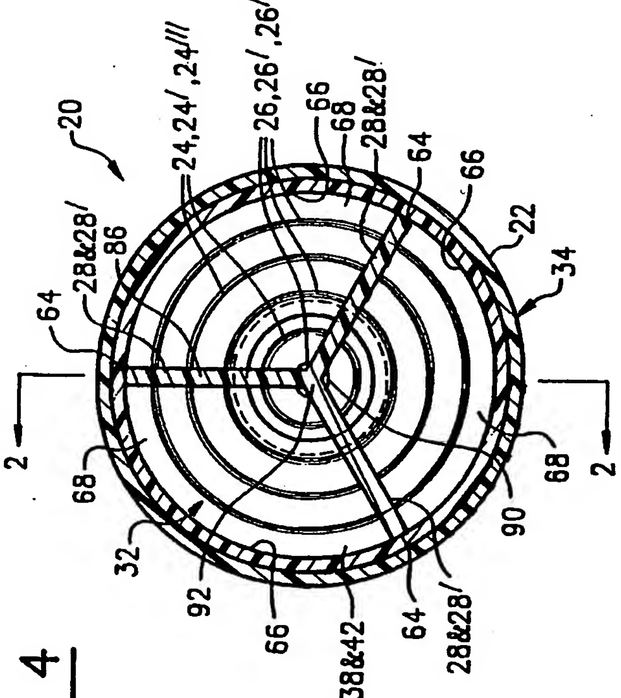
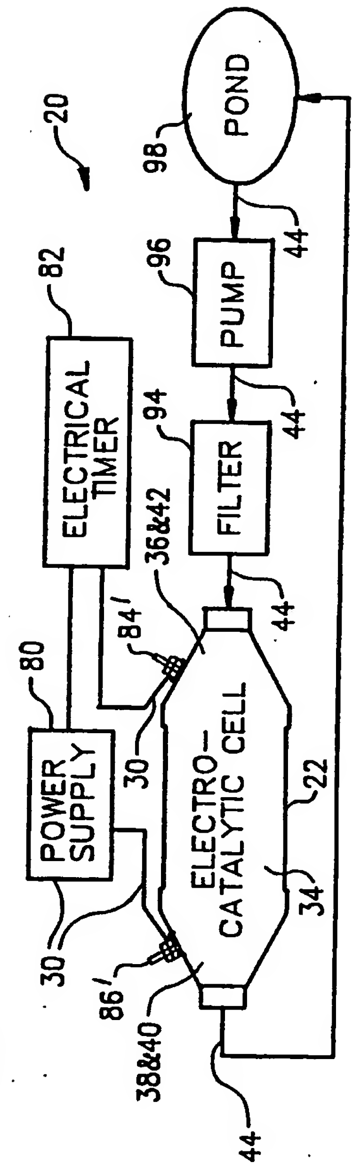

20
24,24',24'''
26,26',26'''
28&28'
86
64
66
68
22
34
2
32
92
90
38&42

FIG. 4


POND
PUMP
FILTER
ELECTRICAL TIMER
POWER SUPPLY
ELECTRO-CATALYTIC CELL
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98
96
94
82
80
84'
86'
36&42
38&40
30
22
34
44

FIG. 5

5/5

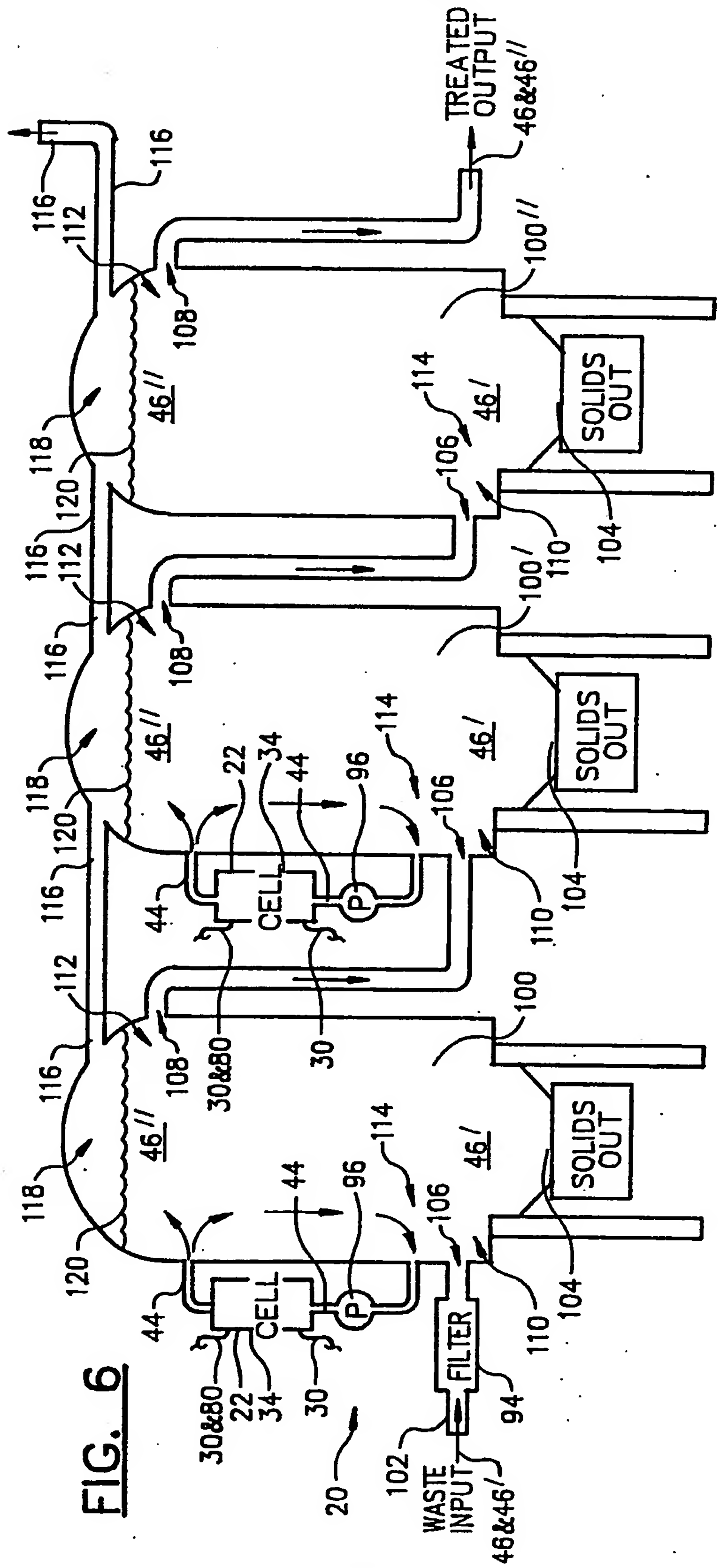
TREATED OUTPUT
46&46''
SOLIDS OUT
SOLIDS OUT
SOLIDS OUT
CELL
CELL
P
P
FILTER
WASTE INPUT
46&46'

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/01730

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :C02F 1/46
US CL : 204/149, 272, 275-278, 290R, 290F
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 204/149, 272, 275-278, 290R, 290F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

none

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 2,864,750 (HUGHES, JR ET AL) 16 December 1958, Figures and col. 3, lines 40-57 and col. 5, lines 43-50.	1, 11-15, 24-25
X	US, A, 3,539,486 (FLECK) 10 November 1970, col. 1, lines 35-60 and col. 3, lines 5-34.	1, 10-13, 22, 24-25
X	US, A, 3,654,119 (WHITE ET AL) 04 April 1972, Figure 1, col. 3, lines 45-55 and col. 5, line 2.	1, 10, 18, 24-25
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[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4,936,979 (BROWN) 26 June 1990, Figure 1 and col. 1, lines 40-68 and col. 3, lines 1-35.	1, 13, 18-19
A	US, A, 3,563,879 (RICHARDS ET AL) 16 February 1971, Figure 1.	1
A	US, A, 4,525,272 (HENSON) 25 June 1985, Figure 1.	1
A	US, A, 4,915,846 (THOMAS, JR ET AL) 10 April 1990, Figures.	1